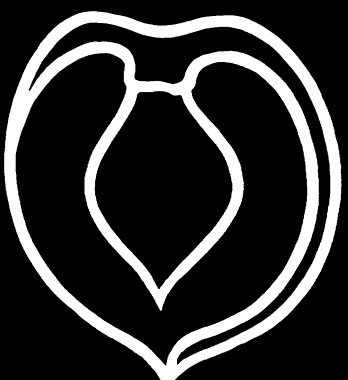
CAUSTIC DRY PEELING OF CLING PEACHES TO REDUCE WATER POLLUTION:

ITS ECONOMIC FEASIBILITY



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The economic feasibility of a new caustic dry method of peeling cling peaches is examined. The dry-peel method, developed as an alternative to the currently used wet-peel method, is designed to reduce the pollution in fruit canneries' wastewaters.

By using the dry-peel method instead of the wet-peel method, a cling pea cannery would generate less wastewater and the pollution level of the water would be lower. The cannery would realize savings in fresh water costs. Sav- ings in wastewater disposal costs would vary, depending on whether wastewater service charges are based partially on the water's biochemical oxygen demand (BOD) or only on the volume of wastewater discharged. Labor requirements would probably not increase. New equipment costs could be largely offset if a replacement cost is allocated for the old wet-peel equipment. Solid waste disposal costs would increase because some of the peeling loss would be recovered as a solid waste rather than being discharged into the wastewater stream. Such added costs would be at least partially offset, however, for canneries located in areas where BOD is a factor in computation of wastewater service charges.

Key Words: Peaches; Fruits; Processed fruit; Canning and fruit; Economic feasibility; Costs; Pollution; Water consumption; Waste.

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PREFACE

To provide better knowledge for planning and implementing programs for expanding market outlets and increasing the efficiency of marketing farm products, the Economic Research Service cooperates with the Agricultural Research Service (ARS) in evaluating opportunities for improving a wide range of agricultural products. Such evaluations are needed by agribusiness firms for judging whether proposed improvements based on research results are commercially feasible and by physical scientists for guiding their research programs.

This report is the result of a cooperative effort of scientists trained in economics, engineering, and chemistry. It presents an economic analysis of alternate methods of peeling cling peaches and indicates the potential impact of a new processing technique designed to facilitate pollution abatement of cannery wastewaters. The simulated plant data used in this report are presented as a model rather than as being representative of the industry.

The authors are grateful for the cooperation of members of the Engineering and Development Laboratory, Western Regional Research Laboratory, ARS; members of the Western Research Laboratory of the National Canners Association; the California Canners and Growers Cooperative; Magnuson Engineers, Inc.; and others.

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SUMMARY

An experimental, caustic dry method of peeling cling peaches, designed to reduce pollution in peach canneries' wastewaters, could at the same time reduce these canneries' operating costs. The quantity and quality of peaches processed under the new method would compare favorably with that processed under the currently used wet-peel method.

Under the new dry-peel method, the volume of wastewater discharged from the peeling operation would be less than under the wet-peel method, and would thus contribute to less overall waste in a community's sewage system. In addition, about one-third of the peeling loss would be collected and kept out of the wastewater stream. This portion of the peeling loss would consist of most of the outer skin of the peaches and any caustic solution adhering to the skin. Under the currently used wet-peel method, all of this material--or slurry--goes into the wastewater stream. Its absence in wastewater from the dry-peel method would mean that the pollution level of the wastewater would be lower.

With the dry-peel method, a cling peach cannery would have savings in fresh water costs because fresh water requirements are less than under the wet-peel method. Also, since the volume of wastewater generated is less, savings in wastewater disposal costs would be realized.

If a cannery is located in an area where wastewater service charges include a separate charge for the biochemical oxygen demand (BOD) in wastewaters, inplant removal of some of the BOD would result in further savings in wastewater disposal costs. However, if the cannery is already treating its wastewaters for 34-percent BOD removal to meet municipal sewage requirements, it could meet these requirements under the dry-peel method without any inplant BOD removal and realize even greater savings.

A cannery would incur additional net capital costs for purchase and installation of new dry-peel equipment if existing wet-peel equipment is considered to be fully depreciated. If, however, a replacement cost is allocated for the wet-peel equipment, such a cost could approach the cost for the dry-peel equipment and thus reduce the net capital cost difference.

Under the dry-peel method, solid waste disposal costs would increase because the slurry, instead of being discharged into the wastewater stream, would have to be disposed of as a solid waste. Such added costs, however, would be partially offset by savings in fresh water costs and savings in wastewater disposal costs in areas where BOD is a computational factor. The added cost for solid waste disposal could possibly be reduced if the capacity of solid waste hauling equipment were to be increased.

Labor requirements under the dry-peel method would probably be the same as under the wet-peel method. No additional labor would be required to handle the peel slurry from the dry-peel operation because such material is removed automatically with the dry-peel equipment. The additional solid waste resulting from the slurry can be removed to dump trucks automatically, so no additional inplant labor for solid waste disposal would be expected.

CAUSTIC DRY PEELING OF CLING PEACHES TO REDUCE WATER POLLUTION: ITS ECONOMIC FEASIBILITY

by Leo R. Gray and Marcus R. Hart 1/

INTRODUCTION

People in the United States are becoming increasingly concerned about environmental quality, particularly as it pertains to water pollution*. Food processors face strong public pressure to clean up wastewater* discharged from their plants. At the same time, the processors are concerned about the additional expenses that may be associated with various approaches to pollution abatement. Pollution controls may be legislated, however, even though such controls may result in higher operating costs for an industry.

Canners of fruits and vegetables are considering various approaches to water pollution abatement. One approach is the expansion of inplant wastewater treatment facilities to reduce to acceptable levels the pollution loading* of discharged plant wastewater. Another approach is to modify current processing methods to (1) reduce the amount of pollutants entering the wastewater; and (2) reduce the quantity of wastewater effluent*.

Solid wastes from cling peach cannery operations are now being screened from wastewaters to reduce pollution loadings. An additional step would be to retrieve the peach slurry*--the peeling losses and any caustic solution adhering to them--before it enters the wastewater flow. Such treatment of waste slurry would, however, add to the solid wastes that must be handled and disposed of.

As an alternative to the existing caustic* wet-peel method of peeling fruits and vegetables, a caustic dry-peel method has received considerable attention as an approach to water pollution abatement. This dry method was developed by scientists in the Engineering and Development Laboratory of the Western Marketing and Nutrition Division (WRRL), Agricultural Research Service, U.S. Department of Agriculture. Under the dry-peel method, both the quantity of wastewater effluent and its pollutional loading are less than under the wet-peel method.

In addition to modifications in peeling methods, alternative blanching techniques are being considered as a means of pollution abatement of cannery wastewaters (1, 18). 2/ These modified blanching methods could result in

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*Terms marked with an asterisk are defined on pp. 27-31.

2/ Underscored numbers in parentheses refer to references listed at the end of this report.

substantial reductions in water consumption as well as less pollution in the wastewater effluent. Steam blanching requires much less water than hot-water blanching. Individual Quick Blanching (IQB) research at WRRL has dealt only with vegetables for freezing. Work is underway at the University of Wisconsin, however, that focuses on IQB of vegetables for canning.

This report evaluates the economic feasibility of the dry-peel method of peeling peaches. The potato industry has had considerable success with a caustic dry-peel method that was developed by WRRL scientists in cooperation with Magnuson Engineers, Inc., of San Jose, California (15). While it is technologically feasible to use a modified caustic dry-peel method on fruits, the canning industry needs more information regarding the economic feasibility of such a method.

Pilot plant-scale equipment and cling peaches were used in the WRRL experiments with the dry-peel method. For purposes of this report, results of the WRRL experiments are adapted to commercial-scale operations. The dry-peel method is compared with the existing wet-peel method in terms of: Fresh water requirements; wastewater volume generated; costs of disposing of wastewater; costs of disposing of solid waste; and costs of inplant treatment of the biochemical oxygen demand (BOD)* in the wastewater. Some consideration is given to labor requirements, caustic soda requirements, and use of recovered solid wastes as an ingredient in animal feed. The economic feasibility of the dry-peel method is analyzed primarily from the processor's point of view.

The quantity of wastewater effluent from a given operation is assumed to approximate the quantity of fresh water influent* for the operation. Some of the water volume lost through evaporation is assumed to be partially offset by wastes from processing that enter the wastewater effluent. The quality of fresh water influent is assumed to be satisfactory, but the wastewater is assumed to be heavily polluted and must be treated prior to return to an open body of water. The quality of wastewater is usually measured in terms of its BOD level and the amount of suspended solids (SS)* in the water.

The study assumes that an industrywide shift to the caustic dry-peel method for cling peaches would require no subsequent adjustments in the consumer and factor markets. The dry-peel method does not alter the form of the peeled peaches from that obtained with the wet-peel method. Thus, demand for canned cling peaches is not expected to be affected. Because the caustic dry peeling method is designed to contribute to pollution abatement, and because it conforms with environmental protection efforts, the canning industry might consider its adoption from the standpoint of improving public relations. Also, a preliminary analysis suggests that additional employment opportunities in handling solid wastes would result for people in nonmetropolitan areas.

Results of this analysis on cling peaches have relevance to other fruits, especially pears and apricots. Peeling losses from the wet and dry methods may differ considerably among fruits, and thus may have different implications for pollution loading in wastewaters. However, other pollution abatement effects and cost factors--such as wastewater service and solid waste handling charges--would most likely be similar for other fruits processed under the dry-peel method.

Before the economic aspects of the dry-peel method are examined, the importance of peach processing in the United States is discussed and a description of the wet and dry methods of peeling cling peaches is presented. Also, the environmental aspects of the dry-peel method are briefly examined.

U.S. PEACH PROCESSING OPERATIONS

Peaches are the most important fruit canned in the United States. Average annual production of canned peaches was 3.28 billion pounds in the 1966-70 crop years, accounting for nearly one-third of the total pack of the 14 leading noncitrus fruits (table 1). California clingstones accounted for nearly half of U.S. canned peach production and for nearly 78 percent of total California peach production (app. table 1). Farm sales of California clingstones averaged over $65 million. Of these sales, 99.8 percent were made to California commercial canning firms. In the 1966-70 crop years, clingstones comprised about 88 percent of all peaches canned in California and 84 percent of all peaches canned in the United States.

Table 1--Canned peaches and 14 leading noncitrus fruit packs, United States, crop years 1966-70

Noncitrus fruit pack	1966	1967	1968	1969	1970	5-year total
	1,000 equivalent cases 24 No. 2-1/2's 1/					
California clingstones	30,348	22,556	29,867	31,479	24,878	139,138
U.S. freestones	5,846	3,977	5,988	6,060	4,663	26,534
All peaches	36,194	26,543	35,855	37,539	29,541	165,672
Total 14 leading noncitrus fruit packs	104,159	88,232	104,986	113,375	91,350	502,102
All peaches as percent of 14 leading packs	34.7	30.1	34.2	33.1	32.3	33.0

1/ Net contents of a standard case of 24 No. 2-1/2 canned peaches weighs 43.5 pounds. Equivalent net weights for the other 13 items vary from 39.0 to 45.0 pounds per case, depending upon the item.

Source: (27, 38).

In 1970, the difference between the quantity of cling peaches processed for canning and the net canned pack was approximately 13 percent (app. table 2). Of this loss, pits accounted for roughly 6.3 percent; peelings for 5.2 percent; and trimmings, culls, and spilled fruit, for 1.5 percent. Cruess (10) indicates that pitted cling peaches undergo a 5.5-percent peeling loss in the commercial lye spray peel operation. Under the existing caustic wet-peel method, all losses from peeling operations enter a cannery's wastewater flow. Most of the pits and other losses are recovered. The pits are utilized as a byproduct, while the other losses are handled as solid wastes.

Wastewater Generated

During peak periods of seasonal operation, a fruit processing plant may use more water and generate more waste than does the community in which it is located. Rose (24, p. 116) indicates: "The pollutional load from a plant may be 200-300 times that in the community of 500-1,000 persons in which the plant is located; or the food waste may be equivalent to twice that of the wastes of a city of 50,000 in which the plant is located."

In 1968, an estimated 82 billion gallons of wastewater were discharged from commercial U.S. fruit and vegetable canning and freezing plants. About 19 percent--15.7 billion gallons--was discharged from plants canning and freezing noncitrus fruits. Peach canneries accounted for 4.4 billion gallons or nearly one-third of the total wastewater effluent for all noncitrus fruits (24, p. 111). Of this, California cling peach canneries accounted for 4.3 billion gallons. In 1970, the volume of effluent was less--about 3.5 billion gallons--because the volume of California clingstones processed was smaller. During 1970, California canneries processed 621,600 raw tons of cling peaches and generated 19,270 tons of BOD; 4,040 tons of SS; and 48,470 tons of solid residuals (app. table 2).

Before discharging wastes into municipal wastewater systems, most peach canneries give preliminary treatment* to these wastes by passing them through vibrating screens* (24, p. 114). Materials recovered from the vibrating screens are disposed of as solid wastes. Further inplant treatment of the wastewater can help reduce the BOD and SS content of the water. Such treatment can occur before or after the solids enter the wastewater streams, but before they enter the municipal sewage system. One of the biggest problems associated with effluent from a fruit cannery is the dissolved material (particularly sugar) from the natural juices of the fruit. Preventing peel slurry from entering the wastewater can substantially reduce the amount of such solids that enter the water.

Composition of Peaches and Peel Waste

A whole cling peach generally consists of approximately 6.3 percent pit and 93.7 percent peel and pulp. The composition of the peel and pulp is about 86.5 percent water and 13.5 percent solids, including 12.9 percent soluble solids (5.7 sucrose, 2.0 reducing sugars, 0.5 ash, 0.5 acids such as malic, 0.3 protein, and 3.9 other) and 0.6 percent insoluble solids. 3/

One analysis of a sample of peach peel waste indicated a pH* of 5.5. Percentage composition of the peel waste was: Moisture--90.0 and total solids--10.0, including 0.2 crude fat, 0.8 crude fiber, 0.9 protein (N x 6.25), 1.4 ash, and 6.7 nitrogen-free extract (26).

Pollutional Loadings from Peach Peeling Operations

Under the current wet-peel method, peeling operations are the major source of pollution loadings in wastewaters of commercial peach canneries. Unit rates indicate that in 1970, this phase of the total processing operation used less than 10 percent of the total fresh water requirements of peach canneries. However, it contributed over half of the BOD and about three-quarters of the SS in the canneries' wastewater effluent (app. table 2).

The volume of wastewater from the peeling operation generally approximates the volume of fresh water used in the operation. The amount lost through evaporation is at least partially offset by unretrieved skins and fixed and dissolved solids emanating from sustained immersion of fruit in the water. Some water used in the peeling and rinsing operation can be recycled. Water used in the lye treatment bath is continually recycled. Rinse water applied immediately after lye treatment is sent directly to a composite of floor drainage and disposed of as waste liquid. Water used in the reel washer and peeling spray rinses can be used in flumes to carry peeled peach halves to an inspection area and then recycled, generally for reuse in the raw material dump area.

Clayton (7) found that a large amount of BOD is generated from the leaching of peaches in water. About half the peach solubles are released during the first half a minute of contact in the water. Although COD* doesn't necessarily correlate with BOD, he indicated that the BOD/COD ratio averaged about 0.62. (BOD is less than COD partly because COD measures the oxygen-consuming capacity of organic matter which is not degraded during the 5-day BOD time period.)

Utilizing Solid Peach Wastes

Virtually no solid wastes are recovered from the wet-peel method of peeling peaches because the slurry--that is, peach peelings and any caustic solution adhering to them--goes into the wastewater stream. In other processing operations that use water, however, suspended solids are recovered in a shaker screen sedimentation treatment before the wastewater is discharged into the municipal wastewater system or into an open stream. These solids are disposed of with other solid fruit wastes from the cannery operations. No determination has been made as to whether any of the peelings adhere to some

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3/ This percentage composition is adapted from data in (43).

of the suspended solids recovered in the shaker screen treatment.

Under the dry-peel method, however, the peel slurry is kept out of the cannery's wastewater effluent. It is combined with some of the other solid fruit wastes, thereby increasing the volume of "dry" solid wastes to be disposed of.

Dumping

Traditionally, solid fruit wastes from canneries have been spread on land, dumped in the ocean, or used as "fill" in urban sanitary landfill operations. However, firms hauling fruit wastes from canneries in the San Francisco Bay Area are subject to increased restrictions from dumping such wastes in the Pacific Ocean. The future for dumping cannery wastes in urban sanitary landfill areas is not too certain, because of concern about environmental quality. An alternative being studied is to return the solid wastes to agricultural land. This report will focus on this alternative for utilizing solid peach waste.

In 1970, a cannery waste disposal project was initiated in an area south of Gilroy, California, by the Cooperative for Environmental Improvement (CEI), a group of San Jose canners. 4/ The project involved recycling over 70 percent of the solid fruit wastes from canneries in the San Jose area. The collected wastes were hauled to a disposal site about 40 to 45 miles from San Jose, spread over about 700 acres of open agricultural land, and plowed into the soil. Preliminary reports indicate the new waste-disposal system is an effective approach that appears to be acceptable in terms of environmental protection. This may become a model method for the recycling of solid wastes from fruit canneries. The capacity of the soil to consume organic wastes has been estimated to be about 200 to 400 tons per acre per year (9).

Animal Feed

Raw solid wastes from commercial fruit canning operations have been used as an ingredient in animal feed. The total-solids portion of peach cannery wastes was considered to be a good source of energy because of its sugar content. It is not known, however, what side effects such solid wastes, as an ingredient in feed, have on animals. California health authorities have restricted the use of such wastes in feed for cattle in the State, largely because of pesticide residues in the waste.

4/ The San Jose canners organized this cooperative to find an alternative to their customary disposal sites. Also working with CEI on the project were scientists from the National Canners Association, the California Agricultural Extension Service (with the University of California and the County of Santa Clara cooperating), and the County Health Departments of San Benito and Santa Clara counties.

The peel drops into a trough located under the peel unit and is collected as solid waste slurry (fig. 2). The slurry in a commerical-scale unit can be removed from the trough periodically by an automated suction pump, and pumped through a pipeline to a receptacle containing other solid wastes. 5/

Peeled peach halves exit from the dry-peel unit through a chute into a surge tank filled with water. While the peach halves are submerged in the tank, most of any remaining loosened skin comes off and is disposed of with the wastewater effluent. Peaches are removed from the surge tank by a conveyor elevator. While on the conveyor, they are rinsed by one to three sprayheads of fresh water. This spray water drains into the surge tank. When the peaches leave the conveyor belt, they are ready for inspection.

The focus of this analysis of the peach peeling and rinsing operation is that portion of the processing that takes place after the pitted peach halves leave the lye application treatment and are drained of excess lye solution, and before they enter the discharge flume waters en route to inspection. Thus, for the wet-peel process, it would include the spray washer and the reel washer operations (where the peaches are peeled and rinsed); while for the new, caustic dry-peel process, it would include the mechanical disk peeler and the fresh water rinser. The time required for this phase of processing was about the same for the two peeling methods when they were tested in experimental runs. In a commercial-scale operation, the volume of major product flow would be similar for both peeling methods.

ENVIRONMENTAL ASPECTS OF DRY-PEEL METHOD

Fresh Water Requirements

Fresh water requirements per ton of peaches peeled by the WRRL dry-peel method amounted to about 6.5 percent of that required for the wet-peel method (table 2). In the commercial wet-peel method, fresh water requirements averaged about 527 gallons per ton of pitted, unpeeled peach halves, of which about two-thirds was used in the initial spray rinse section and one-third in the reel washer. In contrast, only about 34.5 gallons of water per ton of fruit was used in the dry-peel rinse process.

5/ A modification of the WRRL dry-peel unit has been developed in a rotary configuration by Magnuson Engineers, Inc., San Jose, California (fig. 3).

Table 2--Wet and dry methods of peeling cling peaches, selected comparisons

Item	Unit	Wet-peel method	Dry-peel method
Input of pitted, unpeeled peach halves	Lbs./hour	1/ 54,000	5,300
Yield of peeled peach halves	do.	2/ 51,030	4,956
Losses from peeling	do.	2/ 2,970	344
As a percentage of input	Percent	2/ 5.5	6.5
Peel slurry* recovered 3/	Pounds	0	124
As a percentage of losses from peeling	Percent	0	36
Fresh water requirements per ton of raw peach halves	Gallons	527	34.5
Lye concentration of treating solution	Percent	4.0	1.7
Alkalinity of effluent* 4/	pH*value	10.8	9.5
COD* per ton of peach halves 5/	Pounds	59.5	18.1
COD* concentration	mg/l*	13,550	50,200
BOD* per ton of peach halves 5/	Pounds	36.89	11.22
SS* per ton of peach halves 4/	do.	10.4	3.0
SS* concentration 4/	mg/l*	2,375	9,750

*Terms marked with an asterisk are defined on pp. 27-31.

1/ The National Canners Association indicates the average peach cannery in California has the capacity to peel about 30 tons of raw peach halves an hour. The 27-ton operation referred to in this table was an actual process run from which this data were collected.

2/ Yield computed on the basis of 5.5-percent peeling loss according to (10).

3/ Based on experimental data.

4/ Computed from (21).

5/ BOD was not measured directly, but was calculated assuming BOD/COD ratio = .62. BOD/COD ratio taken from (7).

Water requirements for the dry-peel method are lower largely because mechanical abrasion rather than water pressure is used for peel removal. For either peeling method, the amount of water used per ton of product varies with the operating practice. While water used per ton of product varies among products and canneries, and among years in the same cannery, the proportion of gross water supplied by recirculation has increased over the years and the trend is expected to continue (23).

Wastewater Generated

Measurement of wastewater quality per ton of peeled peach halves indicates that comparatively less water pollution was generated from the dry-peel method. The COD and SS generated, in pounds per ton of peach halves, was nearly 70 percent less than that generated by the wet-peel method. Essentially, this was because in the dry process, the volume of wastewater was less and the slurry material was removed as a solid waste. Total wastewater loadings from the peeling operation can be expected to decrease with increasing yields of peeled peach halves per ton of input.

Another measurement of wastewater quality is the pollutional loading strength per unit of wastewater effluent--that is, the concentration in milligrams per liter (mg/l) of the COD and SS. Under the dry-peel method, this concentration was 3.7 times more than that from the wet-peel method in terms of COD, and 4.1 times more in terms of SS (app. table 4). A key factor from the point of view of pollution abatement, however, is that the volume of effluent to be treated for pollutional loading is significantly reduced under the dry process.

Use of the dry-peel method would allow about an 8-percent reduction in total plant wastewaters, but about a 90-percent reduction in wastewater from the peach peeling operation. In addition, to the extent that the peel slurry does not enter the wastewater flow, it would not add to the BOD or SS loading of the effluent. There would still be leaching from the peeled fruit in the water, however, that would contribute to the BOD load. It is estimated that a cannery peeling 15 tons of peach halves an hour, 20 hours a day, could reduce its wastewater effluent by nearly 10 million gallons in a 60-day season if the dry rather than the wet-peel method were used.

Lye Concentration

The amount of lye concentration used in the dry-peel method can be less than that used in the wet-peel method. For most of the experimental runs on both wet and dry methods, lye concentrations were relatively high, primarily because of the different varieties of cling peaches used. However, satisfactory peeling results can be achieved with lye concentrations considerably less than those indicated in table 2 if the quality and variety of peaches are closely controlled. A lower lye concentration can be used with the dry method and still result in yields comparable to those from the wet method because of the relative effectiveness of skin removal by abrasion rather than by water pressure.

Under the dry-peel method, lower alkalinity of the composite effluent would be expected because, although less water is required, the peeled skins are not allowed to enter the wastewater. Instead, the peel slurry, with its high pH value, is retrieved and handled as a solid waste. The alkalinity of dry-peel slurry material, in terms of pH value, tends to decline after it has set for several hours.

Losses From Peeling

Table 2 indicates peeling losses of 5.5 and 6.5 percent, respectively, for the wet and dry peeling methods. About one-third (36 percent) of the peeling loss is recoverable if the dry-peel method is used. Thus, if the dry-peel method had been used in 1970, about 23 million pounds of peel slurry could have been kept out of the effluent discharged from cling peach canneries. In the experimental runs, the quality and quantity yields of peaches peeled by the dry-peel unit were judged to compare favorably with those from the commercial wet-peel units. 6/

Ralls and others (21) reported an overlapping range of peeling losses from the two peeling methods for peaches and for pears and apricots as well (table 3). Results of their experiments with these fruits indicate that there is not enough difference in peeling losses to suggest an economic incentive based on higher product yields for either peeling method. Such an incentive was suggested in the case of a new caustic dry-peel method for potatoes (15, p. 161).

Table 3--Estimated losses from peeling, under wet and dry methods of peeling cling peaches and pears and apricots

Item	Peeling loss as a percentage of input	
	Wet-peel method	Dry-peel method
	Percent	
Apricots	6.4 - 9.3	3.7 - 8.3
Peaches	5.5 - 8.0	5.3 - 7.5
Pears	12.0 - 15.0	11.0 - 20.0

Source: (21).

6/ These judgments were made by industry representatives invited to observe a demonstration of WRRL's dry-peel unit at the Richmond plant of the California Canners and Growers Association in 1970.

Recoverable Solid Waste

Total yields of solid wastes are higher under the dry process than under the wet process because of the considerable increase in recoverable solid waste (namely, the added peel slurry material) from the peeling operation. As mentioned earlier, no solid waste is recovered from the wet-peel method. In contrast, about 46 pounds of peel slurry was recovered per ton of peach halves peeled by the dry method (see table 2). Thus, the recovered peel slurry was about 2.3 percent of the input of unpeeled peach halves. At this rate of recovery, a 30,000-pound-per-hour dry-peel unit would be expected to yield about 690 pounds of peel slurry per hour, or 6.9 tons per 20-hour day.

ECONOMIC FEASIBILITY OF DRY-PEEL METHOD

Costs for freshwater and charges for wastewater disposal are major factors to consider regarding the comparative economics of the wet and dry methods of peeling peaches. Caustic dry peeling offers an opportunity for reduced costs for fresh water, for wastewater treatment, and for wastewater disposal. These potential savings should be matched against likely increases in other costs, namely costs for new peel-removal equipment and charges for disposal of solid wastes. Labor requirements are likely to be similar for both peeling methods, while caustic soda requirements could differ.

Fresh Water Costs

The amount of fresh water used in peach peeling operations would be reduced--and hence, fresh water costs--if the dry rather than the wet-peel method were used. Fresh water requirements and costs for a simulated dry-peel operation in Richmond, California, were estimated. If the plant used the wet-peel method, costs for fresh water consumption would approximate \$6,208 for a 22-day month, while under the dry-peel method, such costs would approximate \$5,687--a difference of \$521, or about 8.0 cents per ton of peach halves peeled. These costs are based on variable rates according to water flows, plus flat service charges for each water meter. Water costs vary considerably, so cost estimates made in this study are not applicable to all situations. Also, meter service charges vary by type and size (table 4 and app. table 3).

Total fresh water costs, covering all operations of the simulated cannery would be about 8 percent lower with the dry-peel method, as would total water consumption. Because of the large volume of flow, flat meter service charges under either peeling method would be less than 3 percent of the total fresh water costs. Estimates of savings in fresh water costs made in this report are computed at the lowest rate per gallon on the rate schedule.

Table 4--Monthly costs for fresh water, wastewater disposal, and solid waste disposal, under wet and dry methods of peeling cling peaches, simulated peach cannery 1/

Cost item	Wet-peel method	Dry-peel method	Difference
		Dollars	
Fresh water:			
Variable flow..........	6,038	5,517	521
Flat meter service.....	170	170	0
Total................	6,208	5,687	521
Wastewater service charge	4,959	4,525	434
Solid waste disposal:			
Additional peel slurry.	0	789	- 789
Other solid wastes.....	549	549	0
Total................	549	1,338	- 789
Total, fresh water and wastes................	11,716	11,550	+ 166
Total cost per ton.......	1.7752	1.7500	0.0252

1/ Data assume that the peach cannery has a peel-unit capacity of 15 tons of raw peach halves per hour and that it operates 20 hours a day, 22 days a month. Fresh water and wastewater service charges are based on rate charges in effect in Richmond, California, in 1971. See table 7 and app. tables 3 and 4.

Wastewater Service Costs

Service charges for wastewater discharged from canneries into municipal sewer systems* vary among locations. Some municipalities assess wastewater service charges as a fixed percentage of the water bill, some have flat rates based on the volume of effluent alone, and some have added charges for "excessive" amounts of BOD and SS. Still others have surcharges that tie volume to pollution indicators such as BOD and SS.

In 1971, industrial (cannery) wastewaters discharged into the Richmond, California, sewer system were charged at the monthly rate of $1.00 per sewer service unit (SSU) connected to the system. There was no additional charge for BOD or SS. Measurement of sewer service charges for industries is computed as one SSU per five plumbing fixtures, or fraction thereof, for the disposal of domestic waste, plus one SSU for that quantity of industrial waste equivalent to 7,480 gallons (equivalent to 1,000 cubic feet) of domestic waste discharged into the sewer system (6). Examples of other industrial wastewater service rates and bases in selected California cities are given in appendix table 5.

Assuming that the amount of wastewater discharged approximates the amount of fresh water consumed, it is estimated that the simulated peach cannery would discharge 37 million gallons of wastewater in a 22-day month if the wet-peel method were used, but about 33.8 million gallons (or 8 percent less) if the dry-peel method were used (see app. table 4). Monthly charges for this wastewater, if released into the Richmond, California, sewer system, would approximate $4,959 under the wet-peel method and $4,525 under the dry-peel method--a savings of $434 (table 4). The wastewater service costs for a comparable peach cannery discharging the same quantity and quality of wastewater would vary widely according to the policies of the local municipality that services the plant.

For peach canneries that might be located in selected California cities, table 5 compares estimates of wastewater service costs under the two peeling methods. Estimates, which are based on the cities' wastewater service charges (app. table 5), suggest that the dry-peel method would have more of a savings impact for those plants serviced by cities having surcharges geared to the amount of BOD and/or SS in the wastewater.

Table 5--Monthly wastewater service charges under wet and dry methods of peeling cling peaches, simulated peach canneries in selected California cities 1/

City	Wet-peel method	Dry-peel method	Difference
		Dollars	
Stockton 2/	10,920	8,328	2,592
Modesto	4,842	3,377	1,465
San Jose	3,958	2,817	1,141
Selma	4,033	2,980	1,053
Sacramento	6,982	6,375	607
Richmond	4,959	4,525	434
Oakland	1,083	996	87
Fullerton	893	815	78
Sunnyvale	6,343	6,343	0

1/ Data assume that the peach canneries have a peel-unit capacity of 15 tons of raw peach halves per hour and that they operate 20 hours a day, 22 days a month. Wastewater service charges are based on rates in effect in the cities in June 1972 (see app. table 5).
2/ A proposed rate change for Stockton would increase charges about 51 percent.

Cost of Inplant Treatment of Wastewater

A major factor affecting wastewater service charges is the volume of wastewater introduced into the sewage system for treatment. If a cling peach cannery used the dry-peel method, wastewater service costs would be less, even without inplant treatment of BOD and SS, because the volume of wastewater would be less. If the plant removed some BOD prior to discharging its wastewater, and if BOD was a factor in the computation of wastewater service charges, wastewater service costs would be even further reduced because the pollution load would be substantially reduced (table 6).

Inplant treatment of wastewaters for BOD removal is a costly operation. If a simulated cannery in Stockton, California, used the wet-peel method and had a trickling filter* treatment to remove about 34 percent of the BOD from its wastewater, the annual cost of this treatment would approximate $21,340. 7/ This cost is more than three times the annual cost of the equipment needed for the dry-peel method. However, the dry-peel method generates about 41 percent less BOD than does the wet-peel method. Thus, even with no BOD treatment under the dry-peel method, there would be less BOD in the wastewater than there would be with 34-percent removal of BOD under the wet-peel method.

With no inplant BOD removal, the surcharges would be $4,405 under the wet-peel method, compared with $2,473 under the dry-peel method--or a difference of $1,932. With 34-percent inplant removal of BOD, the surcharges would be $2,802 under the wet-peel method and $1,533 under the dry-peel method--or a difference of $1,299. The difference in total BOD surcharges for a plant with the wet-peel method and 34-percent BOD removal, and a plant with the dry-peel method and no BOD treatment is $329. This is considerably less than the cost of 34-percent BOD removal. Therefore, processors contemplating a switch to the dry-peel method should give serious consideration to the need for continuing to treat the wastewaters for BOD unless such treatment is required by pollution control regulations.

Equipment Costs

Purchase and installation of a commercial-scale, caustic dry-peel unit capable of peeling 15 tons of raw cling peach halves per hour might approximate $27,000. Annual average maintenance expense is assumed to approximate 10 percent of this cost, depending on the life of the rubber disks. The life expectancy of the equipment (for purposes of depreciation) is estimated to be 12 years 8/, and the average annual interest rate could be about 8 percent. Salvage value for computational purposes is assumed to be zero. The total average annual cost, assuming the above conditions, would be about $6,030, or $0.3350 per ton of raw peach halves if the simulated cannery operated 60 days a year.

7/ Adapted from cost estimates in (41, pp. 72-73).

8/ Twelve years is the estimated life expectancy indicated for depreciation of cannery equipment by the Internal Revenue Service (39, p. 15).

Table 6--Selected data for comparing costs of inplant treatment of wastewater, under wet and dry methods of peeling cling peaches, simulated peach cannery in Stockton, California 1/

Item	Wet-peel method		Dry-peel method	
	No BOD treatment	34% BOD removal	No BOD treatment	34% BOD removal
	Pounds			
Monthly BOD generated:				
Peel operation only	2/ 243,474	2/ 243,474	3/ 74,052	3/ 74,052
All other operations	165,726	165,726	165,726	165,726
Total, all operations	4/ 409,200	4/ 409,200	5/ 239,778	5/ 239,778
Less 34% BOD removal	-	139,128	-	81,525
BOD generated	409,200	270,072	239,778	158,253
Less 200 mg./1 allowance	61,869	61,869	56,453	56,453
Net BOD generated	347,331	208,203	183,325	101,800
	Dollars			
BOD surcharge costs:				
A. Monthly charge @ $5.06 per 1,000 lbs. of BOD greater than 200 mg./1 allowance	1,755.82	1,052.48	925.98	511.06
B. Annual demand charge payable monthly (90% of net BOD poundage for the maximum month of prior year @ $7.20 per 1,000 lbs. of BOD) 6/	2,649.60	1,749.60	1,548.00	1,022.40
C. Total monthly BOD surcharges	4,405.42	2,802.08	2,473.98	1,533.46
34% BOD removal costs:				
Per ton of raw peach halves 7/	-	1.18	-	1.18
Per month		7,788		7,788
Per pound of BOD removed per month 8/	-	.056	-	.096

1/ Data based on May 1972 surcharge rates and simulated peach cannery operations in Stockton, California. Data assume that the cannery has a peel-unit capacity of 15 tons of raw peach halves per hour and that it operates 20 hours a day, 22 days a month.
2/ 36.89 lbs. of BOD generated per ton of raw peach halves.
3/ 11.22 lbs. of BOD generated per ton of raw peach halves.
4/ 62.00 lbs. of BOD generated per ton of raw peach halves.
5/ 36.33 lbs. of BOD generated per ton of raw peach halves.
6/ See app. table A-5.
7/ Adapted from cost estimates in (24). The total average annual cost of trickling filter treatment for 34-percent inplant BOD removal is assumed to be about $21,340 if the simulated plant operated 60 days a year. (Note these costs are based on treatment of wastes with assumed 300/mg./1 BOD. Actually, the BOD concentration of peach wastewater from all operations is assumed to approximate 1,323 mg./1 with the wet-peel method and 849 mg./1 with the dry-peel method (see app. table A-4). These costs are based on the best available published data.
8/ Costs are rounded.

Capital costs for existing wet-peel equipment in the simulated cannery have presumably depreciated considerably. For purposes of this analysis, depreciated value and interest expenses are assumed to be zero. Maintenance expenses, however, are assumed to be the same as they are for the dry-peel equipment. Thus, the total average annual cost for the wet-peel equipment in the simulated cannery would approximate $2,700, or $0.1500 per ton of raw peach halves processed. If capital costs for a simulated wet-peel operation are considered in terms of replacement costs, total average annual costs would increase accordingly. Such costs could approach those for the new dry-peel equipment. Estimates of capital costs for a new wet-peel system, with a capacity comparable to the existing system, would range from about $20,000 to $40,000 installed.

Differences in energy costs for the dry and wet methods are expected to be negligible for a commercial-scale operation. The dry-peel equipment, however, may require somewhat more energy than the wet-peel equipment, primarily because of the mechanical friction used to remove the peel.

Solid Waste Disposal Costs

Under the caustic dry-peel method, the amount of solid waste, excluding pits, that could be recovered from all plant operations would be more than double that recovered under the wet-peel method. Costs for hauling and dumping the solid waste for land disposal at an agricultural site in a 40- to 45-mile radius, and then incorporating it into the soil, would approximate $5.20 per ton of waste (table 7). Assuming costs and solid waste recovery as indicated in table 7, total daily handling costs would amount to about $60 with the dry-peel method and $25 with the wet-peel method--a difference of $0.12 per ton of raw peach halves processed.

The increased tonnage of solid wastes resulting from the dry-peel method may have an effect on unit hauling charges. Trucking firms that haul solid cannery wastes operate around the clock when the canning season peaks. Thus, their labor and equipment charges tend to be fixed, and the major variable cost is the frequency of trips. It is possible, however, that the truckers may find it to their advantage to modify their equipment to more efficiently handle the increased workload. For example, a survey of haulers indicates their equipment capacities range from about 5 to 36 cubic yards per truck. 9/ It appears that firms with more of the larger capacity equipment may be able to service the increased tonnage from canneries with fewer trips and thereby help minimize hauling costs.

9/ Assume 1 cubic yard of waste weighs 0.8 ton.

Table 7--Solid waste disposal costs for a simulated cling peach cannery using the dry-peel method 1/

Item	Solid wastes 2/		
	Peel slurry*	Other solid wastes	Total
		Tons	
Daily solid wastes recovered from all processing operations 3/	6.9	4.8	11.7
		Dollars	
Daily cost for hauling and dumping waste at an agricultural site in a 40- to 45-mile radius, at $4 per ton of waste, or 10 cents a mile per ton of waste 4/	27.60	19.20	46.80
Daily cost for incorporating waste into soil at $1.20 per ton of waste 5/	8.28	5.76	14.04
Total daily cost for land disposal of waste at $5.20 per ton of waste	35.88	24.96	60.84
Total monthly cost	789.36	549.12	1338.48
Total monthly cost per ton of peach halves processed	.1196	.0832	.2028

*Terms marked with an asterisk are defined on pp. 27-31.

1/ Data assume that the cannery has a peel-unit capacity of 15 tons of peach halves per hour and that it operates 20 hours a day, 22 days a month.

2/ Includes solid waste slurry* from the dry-peel operation and solid waste--such as trimmings, culls, and spilled fruit--from other operations. Excludes pits. Data for "other solid wastes" would be the same for the wet- and dry-peel methods. The peel slurry is additional solid waste generated by the dry-peel method.

3/ Recovered wastes from 300 tons of peach halves processed in a 20-hour day, using factors of .023 for peel slurry and .016 for other solid wastes. The latter factor assumes that the other losses shown in app. table 2 are solid wastes that are recoverable under either the wet or dry methods of peeling peaches.

4/ This rate approximates 1971 rates for hauling and dumping solid wastes from canneries in San Jose, California. In early 1972, average hauling charges increased somewhat, but dumping charges decreased, resulting in a somewhat lower total rate.

5/ Cost estimate for spreading solid wastes from canneries on agricultural land with leased equipment in 1970, excluding transportation.

Source: (9).

Solid Wastes As A Feed Ingredient

The relatively low solids content of solid fruit waste from peach canneries limits its usefulness as a feed ingredient in terms of its nutrient value, especially when compared with competing products. For example, sugar-cane molasses, which sells for $25 to $30 a ton in San Francisco, is composed of about 64 percent sugars, 11 percent other dry matter, and about 25 percent moisture.

Peach cannery waste, because of its high water content, could be used to moisten dry feeds and help keep down dusts, but water has been identified as a component responsible for spontaneous heating and spoilage in mixed feeds (22, p. 23).

Solid peach waste ferments readily and is not very stable in terms of the energy values derived largely from sugars and proteins. Bacterial action during fermentation of the sugars tends to neutralize the slurry.

Some other deterrents to use of peach cannery solid wastes as an ingredient in animal feeds are: (1) the wastes are highly seasonal--they are available only about 3 months a year; (2) variability of the waste product, due to maturity, variety, and quality of the incoming fruit and the caustic concentration required for satisfactory peeling; and (3) proximity of potential user to the cannery and cost of hauling and storage.

Labor Requirements

The number of workers assigned to a dry-peel unit would probably be the same as the number generally assigned to a wet-peel unit. No additional labor would be required to handle the peel slurry from the dry-peel operation because, as indicated earlier, such material can be removed automatically with the dry-peel equipment. The additional solid waste resulting from the peel slurry can also be removed to dump trucks automatically, so no additional in-plant labor costs for solid waste disposal would be expected.

Caustic Soda Costs

Under the dry-peel method, caustic soda (NaOH) costs can be lower per ton of peach halves peeled. Estimates of caustic soda costs under the wet and dry peeling methods cannot be made, however, because data on actual consumption under the two methods are inadequate.

Summary Comparison of Cost Data

Table 8 compares computations of operating cost differences that would result from caustic dry peeling of cling peaches. Under computation A--for a simulated plant in Richmond, California--wastewater disposal charges are based only on the volume of wastewater discharged from the cannery. For the dry-peel method under this computation, the net difference in fresh water costs, wastewater disposal charges, and peel-removal equipment costs (subtotal I) is a loss of approximately 4 cents per ton of raw peach halves processed. Greater differences are indicated for these factors when they are considered separately.

Under computation B--for a simulated plant in Stockton, California--wastewater volume is again considered, but the calculation also takes into account the pollutional load of the wastewater. In this instance, differences in fresh water costs, wastewater disposal charges, and peel-removal equipment costs range from a savings of 18 to 28 cents per ton of raw peach halves peeled by the dry-peel method.

The cost differences increase in computation A, but decrease in computation B, when solid waste disposal charges are considered (subtotal II). Such charges are the same under computations A and B, but they are considerably less than the savings indicated in subtotal I for computation B.

If costs for 34-percent inplant BOD removal under the wet-peel method only are considered, the data suggest that savings could be realized in both areas with the dry-peel method. If the cannery is already treating its wastewater for 34-percent BOD removal to meet municipal sewage requirements, it could meet these requirements under the dry-peel method without any inplant BOD removal and realize even greater savings.

POTENTIAL INDUSTRY SAVINGS

Appendix table 3 contains information on the cling peach processing industry in California in 1968 and 1970. To obtain a rough idea of the impact of the dry-peel method on this industry, data from appendix table 3 can be applied to the per ton cost estimates in table 8.

If all California cling peach canneries had used the dry-peel method in 1970, and if all factors were as indicated in this report, over 11,500 tons of peel slurry would have been recovered from the 621,000 tons of cling peaches processed for canning that year. This volume of peel slurry--and hence, additional solid waste--would have resulted in an industrywide loss of about \$93,000 under computation A. But if costs were estimated according to computation B, a savings of \$98,000 might have resulted.

If 34-percent inplant BOD removal had been required to meet pollution regulations with the wet-peel process, but if no such BOD removal were required with the dry-peel process, savings would have amounted to nearly \$594,000 under computation A and to nearly \$643,000 under computation B.

Table 8--Summary comparison of costs per ton of raw cling peach halves peeled, under wet and dry methods of peeling peaches, simulated plants in two areas of California 1/

Cost item	Computation A 2/			Computation B 3/					
				No BOD* removal			34% BOD* removal		
	Wet-peel method	Dry-peel method	Difference	Wet-peel method	Dry-peel method	Difference	Wet-peel method	Dry-peel method	Difference
	Dollars								
Fresh water	0.9406	0.8617	0.0789	0.9483	0.8668	0.0815	0.9483	0.8668	0.0815
Wastewater service	0.7514	0.6856	0.0658	1.6545	1.2620	0.3925	1.4102	1.1195	0.2907
Peel-removal equipment 4/	0.1500	0.3350	(-)0.1850	0.1500	0.3350	(-)0.1850	0.1500	0.3350	(-)0.1850
Subtotal I	1.8420	1.8823	(-)0.0403	2.7528	2.4638	0.2890	2.5085	2.3213	0.1872
Solid waste disposal	0.0832	0.2028	(-)0.1196	0.0832	0.2028	(-)0.1196	0.0832	0.2028	(-)0.1196
Subtotal II	1.9252	2.0851	(-)0.1599	2.8360	2.6666	0.1694	2.5917	2.5241	0.0676
Inplant wastewater treatment for 34% BOD* removal:									
A. Under both wet and dry methods of peeling	1.1800	1.1800	-0-				1.1800	1.1800	-0-
B. Under wet-peel method	1.1800	-0-	1.1800		-0-		1.1800	-0-	1.1800
Total with treatment A	3.1052	3.2651	(-)0.1599				3.7717	3.7041	0.0676
Total with treatment B	3.1052	2.0851	1.0201		5/ 2.666		5/ 3.7717	2.5241	1.2476

*Terms marked with an asterisk are defined on pp. 27-31.

1/ Data assume that the canneries have a peel-unit capacity of 15 tons of raw peach halves per hour and they operate 20 hours a day, 22 days a month.

2/ Wastewater service charge is computed on the basis of wastewater volume only. Rates for wastewater disposal and fresh water are those in effect in Richmond, California, in the spring of 1972 (see app. table 4).

3/ Wastewater service charge is computed on the basis of wastewater volume and on the pollutional load of the wastewater. Rates for these charges and for fresh water are those in effect in Stockton, California, in the spring of 1972 (see app. table 4).

4/ Capital cost estimates assume that the purchase price for dry-peel equipment, complete and installed, f.o.b. shipper, excluding taxes, is $27,000; salvage value is zero; and life expectancy is 12 years. Thus, total average annual cost, in dollars per ton of raw peach halves processed, is: depreciation (0.1250) + interest (0.1500) + maintenance (0.060) = 0.3350.

5/ The difference in these totals is $1.1051.

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DEFINITION OF TERMS

Biochemical oxygen demand (BOD) -- (1) The quantity of oxygen used in the biochemical oxidation of organic matter in a specified time, at a specified temperature, and under specified conditions. (2) A measure of the amount of oxygen an impure water system requires in a specified time to decompose the polluting agents in the system. (3) A standard test used in assessing wastewater strength.

BOD load -- The BOD content, usually expressed in pounds per unit of time, of wastewater passing into a waste treatment system or into a body of water.

Caustic (or lye) -- A strong alkaline solution, such as sodium hydroxide ($NaOH$), which, when applied to organic tissue, corrodes it by chemical action.

Chemical oxygen demand (COD) -- A measure of the oxygen-consuming capacity of inorganic and organic matter in water or wastewater. It is expressed as the amount of oxygen consumed from a chemical oxidant in a specific test. It does not differentiate between stable and unstable organic matter and thus does not necessarily correlate with BOD. Also known as OC and DOC, oxygen consumed and dichromate oxygen consumed, respectively.

Composite wastewater sample -- A combination of individual samples of water or wastewater taken at selected intervals, generally hourly for some specified period, to minimize the effect of the variability of the individual sample. Individual samples may have equal volume or may be roughly proportioned to the flow at time of sampling.

Discharge -- (1) As applied to a stream or conduit, the rate of flow, or volume of water flowing into the stream or conduit at a given place and within a given period of time. (2) The passing of water or other liquid through an opening or along a conduit or channel. (3) The rate of flow of water, silt, or other mobile substances which emerge from an opening, pump, or turbine, or pass along a conduit or channel, usually expressed as cubic feet per second, gallons per minute, or million gallons per day.

Dissolved solids (DS) -- The total amount of dissolved material, organic and inorganic, contained in water or wastes. Excessive DS can make water unsuitable for industrial uses, unpalatable for drinking, and even cathartic. Potable water supplies may have a dissolved solid content from 20 to 1000 mg./1, but sources which have more than 500 mg./1 are not recommended by the U.S. Public Health Service.

Domestic wastewater (sewage) -- Wastewater derived principally from dwellings, business buildings, institutions, and the like. It may or may not contain groundwater, surface water, or storm water.

Effluent -- Wastewater or other liquid, partially or completely treated, or in its natural state, that flows out of a containing space such as a reservoir, basin, treatment plant, or part thereof.

Filter -- A device or structure for removing solid or colloidal material, usually of a type that cannot be removed by sedimentation, from water, wastewater, or other liquid. The liquid is passed through a filtering medium.

Flume -- (1) A long narrow channel for gravity flow of liquid from one point to another. An open conduit of wood, masonry, or metal constructed on a grade and sometimes elevated. (2) To transport in a flume, as fruits or vegetables.

Industrial wastewater -- Wastewater in which the liquid wastes from industrial processes, as distinct from domestic or sanitary wastes, predominate. See domestic wastewater.

Influent -- Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment plant, or any unit thereof.

Land disposal -- (1) Disposal of wastewater onto land by spray or surface irrigation. (2) Disposal of solid waste materials by incorporating the solid waste into the solid by cut-and-fill techniques or by sanitary landfill operations.

Loading -- The quantity of waste, expressed in gallons (hydraulic load) or in pounds of BOD, COD, suspended or volatile solids (organic load) which is discharged into a wastewater treatment facility.

Milligrams per liter (mg./l) -- A unit of the concentration of water or wastewater constituent. It is 0.001 g of the constituent in 1,000 ml of water. It has replaced the unit formerly used commonly, parts per million, to which it is approximately equivalent, in reporting the results of water and wastewater analysis.

Parts per million (ppm) -- The number of weight or volume units of a minor constituent present with each 1 million units of the major constituent of a solution or mixture. Formerly used to express the results of most water and wastewater analyses, but more recently replaced by the ratio milligrams per liter.

pH -- A value that expresses the degree of acidity or alkalinity of a substance or solution. The extreme readings are 0 and 14. Pure (neutral) water has a pH value of 7.0--it is neither acid nor alkaline. The degree of alkalinity increases as the numbers increase above 7.0. Conversely, for values below pH 7.0, the degree of acidity increases as the numbers decrease. Alkaline water will tend to form a scale, acid water is corrosive. A solution with a pH of 11.0 is 10 times more alkaline than one with a pH value of 10.0, and 100 times greater than pH 9.0.

Pollution -- Broadly, pollution means any change in water quality that impairs it for the subsequent user.

Pollutional load -- (1) The quantity of material in a waste stream that requires treatment or exerts an adverse effect on the receiving system. (2) The quantity of material carried in a body of water that exerts a detrimental effect on some subsequent use of that water.

Population equivalent -- A means of expressing the strength of organic material in wastewater. Domestic wastewater consumes an average of 0.17 lb. of oxygen per capita per day, as measured by the standard BOD test. This figure has been used to measure the strength of organic industrial waste in terms of an equivalent number of persons. For example, if an industry discharges 1,000 pounds of BOD per day, its waste is equivalent to the domestic wastewater from 6,000 persons ($1,000 \div 0.17 = 6,000$).

Preliminary treatment -- (1) The conditioning of a waste at its source before discharge to remove or to neutralize substances injurious to sewers and treatment processes or to effect a partial reduction in load on the treatment process. (2) In the treatment process, unit operations, such as screening and comminution, that prepare the liquid for subsequent major operations.

Primary treatment -- (1) The first major (sometimes the only) treatment in a wastewater treatment works. Commonly considered to include bar racks, grit chambers, comminution, sedimentation and sludge digestion treatment operations, may include flocculation or disinfection. (2) The removal of a substantial amount of suspended matter, but little or no colloidal and dissolved matter.

Recycling -- An operation in which a substance is passed through the same series of processes, pipes, or vessels more than once.

Screen -- A device with openings of uniform size, used to retain or remove solids in flowing water or wastewater and to prevent them from entering an intake or passing a given point in a conduit. The screening element may consist of parallel bars, rods, wires, grating, wire mesh, or perforated plate, and the openings may be of any shape, although they are usually circular or rectangular.

Secondary wastewater treatment -- The treatment of wastewater by biological methods after primary treatment by sedimentation. Common methods of treatment include trickling filtration, activated sludge processes, and oxidation.

Sediment -- Solid material settled from suspension in a liquid.

Sewage -- The spent water of a community. Term now being replaced in technical usage by the term wastewater. See wastewater.

Sewage charge -- See wastewater charge.

Sewage rate -- See wastewater rate.

Sewer system -- Collectively, all of the property involved in the operation of a sewer utility. It includes land, wastewater lines and appurtenances, pumping stations, treatment works, and general property. Occasionally referred to as a sewerage system.

Slurry -- A watery mixture or suspension of insoluble matter (such as mud, lime, wood pulp).

Suspended solids (SS) -- (1) Solids that either float on the surface of, or are in suspension in, water, wastewater, or other liquids, and which are largely removable by laboratory filtering. (2) The quantity of material removed from wastewater in a laboratory test, as prescribed in "Standard Methods for the Examination of Water and Wastewater" and referred to as filterable residue (National Canners Association).

Tertiary treatment -- Treatment beyond normal or conventional secondary methods for the purpose of increasing water re-use potential.

Trickling filter -- A structure containing an artificial bed of coarse material, such as broken stone, clinkers, slate, slats, or plastic materials, over which wastewater is distributed or applied in drops, films, or spray from troughs, drippers, moving distributors, or fixed nozzles, and through which the wastewater trickles to the underdrains, giving opportunity for the formation of zoogleal slimes which clarify and oxidize the wastewater.

Wastewater -- The spent water of a community. From the standpoint of source, it may be a combination of the liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and storm water that may be present. In recent years, the word wastewater has taken precedence over the word sewage.

Wastewater charge -- A service charge made for providing wastewater collection and/or treatment service. A specific charge in contrast to an ad valorem tax. Also see <u>wastewater rate</u>.

Wastewater influent -- Wastewater as it enters a wastewater treatment plant or pumping station.

Wastewater rate -- A charge or a schedule of charges for the collection or the collection and treatment of wastewater to users who are connected to the system. It may be based on water consumption, wastewater flow, strength of wastewater, number and type of plumbing fixtures, or some combination of these.

Wastewater treatment -- Any process to which wastewater is subjected to remove or alter its objectional constituents and thus render it less offensive or dangerous.

Water consumption -- The quantity, or quantity per capita, of water supplied in a municipality or district for a variety of uses or purposes during a given period. It is usually taken to mean all uses included within the term municipal use of water and quantity wasted, lost, or otherwise unaccounted for.

Water treatment -- The filtration or conditioning of water to render it acceptable for a specific use.

Appendix table 1--Production of peaches and utilization of sales, California, clingstones, and United States, all varieties, crop years 1966-71

Area, variety, and crop year	Production 1/	Utilization of sales				
		Fresh market	Processed			
			Canned	Frozen	Dried	Other
			1,000 tons			
California clingstones:						
1966	839.00	2.40	751.80	-	-	-
1967	688.00	1.20	608.00	-	-	-
1968	854.00	1.40	766.30	-	-	-
1969	900.00	1.30	784.70	-	-	-
1970	721.00	1.40	621.60	-	-	-
1971	639.00	1.30	576.70			
U.S., all peaches:						
1966	1,702.50	618.95	914.40	44.10	22.00	5.50
1967	1,342.50	484.40	706.70	48.45	12.75	11.00
1968	1,795.50	680.75	937.30	54.80	18.30	17.90
1969	1,832.50	709.65	936.75	29.95	28.10	14.25
1970	1,518.00	609.40	735.60	36.85	18.20	8.15
1971	1,444.45	616.85	697.80	40.65	14.90	13.25

1/ Production of California clingstones includes culls and cannery diversion, in thousands of tons, as follows: 1966--84.8; 1967--78.8; 1968--86.3; 1969--114.0; 1970--98.0; and 1971--61.0

Source: (28-32 and 33-37).

Appendix table 2--Input, losses, yields, and wastes generated, cling peach canning operations, California, wet-peel method, 1968 and 1970, and simulated dry-peel method, 1970

Item	Unit	Wet-peel method 1968	Wet-peel method 1970	Dry-peel method, 1970	Dry peel as % of wet peel, 1970
Input:					
California clingstones processed for canning 1/	Raw tons	766,300	621,600	621,600	-
Losses and yields:					
Losses from pits 2/	Tons	48,277	39,161	39,161	-
Yield of unpeeled peach halves	do.	718,023	582,439	582,439	-
Losses from peeling 3/	do.	39,491	32,034	32,034	-
Yield of peeled peach halves	do.	678,532	550,405	550,405	-
Other losses 4/	do.	28,925	9,309	9,309	-
Net canned pack 5/	do.	649,607	541,096	541,096	
Wastes generated: 6/					
Wastewater effluent--					
Total from plant:					
@ 5,620 gal. per ton	Mil. gal.	4,306.6	3,493.4	-	-
@ 5,128 gal. per ton	do.			3,187.6	91.2
From peeling operation:					
@ 527 gal. per ton	do.	378.4	306.9	-	-
@ 34.5 gal. per ton	do.	-	-	20.1	6.5
BOD*--					
Total from plant:					
@ 62.0 lbs. per ton	Tons	23,755	19,270	-	-
@ 36.33 lbs. per ton	do.	-	-	11,291	58.6
From peeling operation:					
@ 36.89 lbs. per ton	do.	13,244	10,743	-	-
@ 11.22 lbs. per ton	do.	-	-	3,267	30.4
COD* from peeling operation only--					
@ 59.5 lbs. per ton	do.	21,361	17,328	-	-
@ 18.1 lbs. per ton	do.	-	-	5,271	30.4
SS*--					
Total from plant:					
@ 13.0 lbs. per ton	do.	4,981	4,040	-	-
@ 5.6 lbs. per ton	do.	-	-	1,740	43.1
From peeling operation:					
@ 10.4 lbs. per ton	do.	3,734	3,029	-	-
@ 3.0 lbs. per ton	do.	-	-	874	28.9
Recoverable peel slurry* @ .36 of peel loss	do.	0	0	11,532	-

*Terms marked with an asterisk are defined on pp. 27-31. 1/ Data adapted from app. table 1. 2/ Losses from pits are computed at 6.3 percent of input (43). 3/ Losses from peeling are computed at 5.5 percent of unpeeled peach halves (10). It is assumed that lye applications and peeling losses are the same for the wet- and dry-peel methods. 4/ Includes losses not accounted for in the pitting and peeling operations. Such losses would come from trimming culls and from spilled fruit during other processing operations. These losses are residuals to get net canned pack. 5/ Data adapted from text table 1. 6/ Total plant wastewater effluent, BOD, and SS for wet-peel method obtained from (19).

Appendix table 3--Computation of fresh water costs for a simulated cling peach cannery, under wet and dry methods of peeling peaches 1/

Item	Unit	Wet-peel method	Dry-peel method	Dry-peel as % of wet-peel
Water consumption:				
Daily, all operations 2/	Gallons	1,686,000	1,538,400	91.2
Daily, peeling operations 3/	do.	158,100	10,350	6.5
Monthly, all operations	do.	37,092,000	33,844,800	
	Cu. ft. 4/	4,958,822	4,524,696	
Flow rate, based on 1-month meter readings: 5/				
First 3,000 cu. ft. @ $0.22/100 cu. ft.				
Next 30,000 cu. ft. @ $0.20/100 cu. ft.				
Next 300,000 cu. ft. @ $0.14/100 cu. ft.				
All over 333,000 cu. ft. @ $0.15/100 cu. ft.				
Monthly flow rate	Dollars	6,037.59	5,516.64	
Flat meter service charge, based on size of meter: 6/				
8" fire service				
8" regular service				
6" regular service				
Flat meter service	do.	170.00	170.00	
Total monthly water cost	do.	6,207.59	5,686.64	91.6

1/ Data assume that the cannery has a peel-unit capacity of 15 tons of raw peach halves per hour and that it operates 20 hours a day, 22 days a month.

2/ Total water consumption for all operations computed on basis of approximately 5,620 gallons per ton with wet-peel process and adjusted total of 5,128 gallons per ton with dry-peel process (5620 - 527 + 34.5 = 5128).

3/ Computed on the basis of experimental runs: 527 gallons per ton with the wet-peel method and 34.5 gallons per ton with the dry-peel method.

4/ 7.48 gallons per cubic foot.

5/ Rate/basis data are those in effect in Richmond, Calif., in 1971.

Appendix table 4--Characteristics of wastewater from a simulated cling peach cannery, and wastewater service costs, under wet and dry methods of peeling peaches 1/

Item	Unit	All processing operations		Peeling operations		Peeling operation as percentage of all operations		Dry process as percentage of wet
		Wet	Dry	Wet	Dry	Wet	Dry	
Total wastewater* generated:								
Per ton of peaches 2/	Gals.	5,620	5,128	527	34.5	9.38	0.67	6.5
Per day	do.	1,686,000	1,538,400	158,100	10,350			
Per month	do.	37,092,000	33,844,800	3,478,200	227,700			
BOD* generated:								
Per ton of peaches 2/	Pounds	62	36.33	36.89	11.22	59.5	30.88	30.4
Per day	do.	18,600	10,899	11,067	3,366			
Per month	do.	409,200	239,778	243,474	74,052			
Mg./1 per million*		1,323	849	3/ 8,401	3/31,124			
COD* generated:								
Per ton of peaches 2/	Pounds	100	58.6	59.5	18.1	59.5	30.88	30.4
Per day	do.	30,000	17,580	17,850	5,430			
Per month	do.	660,000	386,760	392,700	119,460			
Mg./1 per million*		2,134	1,370	13,550	50,200			
SS* generated:								
Per ton of peaches 2/	Pounds	13	5.6	10.4	3.0	80.0	53.57	28.8
Per day	do.	3,900	1,680	3,120	900			
Per month	do.	85,800	36,960	68,640	19,800			
Mg./1 per million*		277	131	2,375	9,750			
pH* generated		NA	NA	10.8	9.5			
Wastewater service units per day @ 7,480 gals. (or 1000 cu. ft.) per unit		225.4	205.7	21.1	1.4	9.4	0.68	6.6
Wastewater service units per month @ 7,480 gals. (or 1000 cu. ft.) per unit		4,958.8	4,525.4	464.2	30.8			
Wastewater service cost per month @ $1/wastewater service unit 4/	Dols.	$4,958.80	$4,525.40					

*Terms marked with an asterisk are defined on pp. 27-31. 1/ Data assume that the simulated peach cannery has a peel-unit capacity of 15 tons of peach halves per hour and that it operates 20 hours a day, 22 days a month. 2/ For all processing operations and peeling operations under the wet-peel method, data are based on industry standards. For peeling operations under the dry-peel method, data are based on results of experimental runs. Data for all processing operations under the dry-peel method are based on these peeling operation data. 3/ Computed on the basis of an assumed BOD/COD ratio of .62. 4/ Rate/basis data are those in effect in Richmond, Calif., in 1971.

Appendix table 5--Sewer service charges for industrial users of municipal sewage treatment facilities, selected California cities, June 1, 1972

City	Rate/basis, monthly
Fullerton	12 percent of variable flow portion of water bill.
Modesto	Basic rate based on either sewage discharged or water used.
	Charge per month / Flow basis, monthly
	Inside city limits : Outside city limits
	\$10.00 ; \$20.00 ; 22,440 gals. 1/
	\$.1470/1000 gals. 1/ ; \$.2272/1000 gals. 1/ ; Next 89,760 gals. 1/
	\$.1203/1000 gals. 1/ ; \$.1737/1000 gals. 1/ ; Next 1,383,800 gals. 1/
	\$.1069/1000 gals. 1/ ; \$.1470/1000 gals. 1/ ; Next 2,244,000 gals. 1/
	\$.0802/1000 gals. 1/ ; \$.1069/1000 gals. 1/ ; Next 3,740,000 gals. 1/
	\$.0534/1000 gals. 1/ ; \$.0668/1000 gals. 1/ ; Over 7,480,000 gals. 1/
	BOD Surcharge, monthly If BOD > 300 mg./1, then \$.80/100 lbs. BOD > 300 mg./1
Oakland	\$.0936/1000 gals. 1/ ≤ 299,200 gals. 1/ \$.0535/1000 gals. 1/ 299,201 - 2,992,000 gals. 1/ \$.0267/1000 gals. 1/ 2,992,000 gals. 1/
Richmond	\$.1337/1000 gals. 1/
Sacramento	Basic rate: \$.2272/1000 gals. 1/ ≤ 187,000 gals. 1/ \$.1604/1000 gals. 1/ 187,001 - 561,000 gals. 1/ \$.1069/1000 gals. 1/ 561,000 gals. 1/
	Surcharge: If BOD or SS or both > 400 mg./1, then rate is \$.03/748 gals. higher up to 1000 mg./1
	If BOD or SS or both > 1000 mg./1, then cost increases \$.01 for each 748 gals. for each 100 mg./1 over 1000.
San Jose	Basic rate: \$.0602/1000 gals. 1/ Surcharge: \$.0045/1b. for BOD and/or SS > free allowance. BOD and/or SS Free Allowance: If wastewater flow < 1 mgd, allow 300 mg./1 per day; if wastewater flow > 1 mgd, allow 2500 lbs. per 24 hours.
Selma	I Volume: Monthly charge \$11.00 ; First 25,000 gals. \$ .09/1000 gals. ; Next 975,000 gals. \$ .07/1000 gals. ; >1,000,000 gals.
	II Strength: Monthly charge No charge ; 0 - 300 mg./1 of BOD \$ .33/100 lbs. ; 300 - 1000 mg./1 of BOD \$ .55/100 lbs. ; >1000 mg./1 of BOD
	III Demand: Charged monthly throughout the year \$ .55/1000 lbs. ; 40% of the flow for the maximum thirty (30) day period of the previous year. \$11.00/million gals. ; 40% of the flow for the maximum 30 day period of the previous year.
	Outside city service: Charges for discharging industrial waste into the sewer system from points of origin outside the County Sanitation District shall be double the rate for point of origin inside the District.
Stockton	Monthly charges based upon recorded effluent flow into the sanitary sewerage system.
	1. \$ 30.00 per 1,000,000 gals. of effluent 2. \$ 5.06 per 1,000 pounds of BOD > 200 mg./1 3. \$350.00 flat rate customer charge 4. \$ 60.00 flat rate storm sewer charge

Appendix table 5--Sewer service charges for industrial users of municipal sewage treatment facilities, selected California cities, June 1, 1972 (Continued)

<table>
<tr><th>City</th><th>Rate/basis, monthly</th></tr>
<tr><td>Stockton
(Continued)</td><td>Annual demand charge computed from records maintained for each account and payable annually in July or in 12 equal monthly installments.

1. Ninety (90) percent of BOD poundage for the maximum month of the prior year: $7.20 per 1000 pounds.
2. Ninety (90) percent of effluent volume for the maximum month of the prior year: $150.00 per 1,000,000 gallons.</td></tr>
<tr><td>Sunnyvale</td><td>Minimum annual sewer service charge is $76,117 regardless of flow, payable in 12 installments.
Plus BOD surcharge, if in peak month:
<table>
<tr><th colspan="2">2-day average</th><th colspan="2">7-day average</th></tr>
<tr><td>No charge</td><td><40,000 lbs.</td><td>No charge</td><td><30,000 lbs.</td></tr>
<tr><td>$2.70/1000 lbs.</td><td>40,000 - 50,000 lbs.</td><td>$2.70/1000 lbs.</td><td>30,000 - 40,000 lbs.</td></tr>
<tr><td>$3.00/1000 lbs.</td><td>50,000 - 60,000 lbs.</td><td>$3.00/1000 lbs.</td><td>40,000 - 50,000 lbs.</td></tr>
<tr><td>$3.25/1000 lbs.</td><td>>60,000 lbs.</td><td>$3.25/1000 lbs.</td><td>50,000 - 60,000 lbs.</td></tr>
<tr><td></td><td></td><td>$4.00/1000 lbs.</td><td>>60,000 lbs.</td></tr>
</table>
</td></tr>
</table>

1/ Municipal code rates are quoted in terms of cubic feet. Rates used in this report are on a gallon-equivalent basis, where 1 cubic foot = 7.48 gallons.